MEASUREMENT OF WATER SUPPLY BY THE PITOT TUBE IN SYRACUSE, NEW YORK

By H. R. Starbird[1]

The city of Syracuse obtains its water supply from Skaneateles Lake, situated about 19¼ miles southwest of the city, at an elevation of 465 feet above the Erie Canal. This lake covers an area of nearly 14 square miles, with a total water-shed of approximately 74 square miles, yielding an average of 55 million gallons per day. Of this, 27.5 million gallons per day is, at present, used to supply the city.

Two conduits carry the supply, by gravity, from the Lake to the distribution reservoir and stand-pipe, located in the south-westerly part of the city. The reservoir, with a water surface 245 feet below the level of the Lake has a capacity of 121 million gallons and the stand-pipe, with an overflow 109 feet above the reservoir level, has a capacity of 1¼ million gallons.

The first conduit, of cast iron pipe 30 inches in diameter, was laid in 1894, and the second one in 1908. The latter, also of cast iron pipe, is 42 inches in diameter for the first 1½ miles, with the remaining 17¾ miles of 30-inch diameter.

The distribution system of the city, consisting of nearly 240 miles of mains, ranging from 4 inches to 36 inches, is fed from the reservoir by two lines of 36-inch, and one line of 30-inch diameter pipe supplying the low service, and one line of 24 inch pipe supplying the high service section of the city from the stand-pipe.

No provision had been made, when the conduits were installed, for measuring the flow, either from the Lake or the reservoir, until 1913, when two Pitot Tube Recorders were placed on the 36-inch mains from the reservoir. Later similiar recorders were installed on the other two feed mains, and also on the two conduits entering the reservoir.

Early in 1920, it became apparent that the demand for water, during at least part of the year, would equal if not exceed the supply, and it was considered advisable to check the amount of water leaving

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the Lake against that delivered to the reservoir, in order quickly to detect any considerable loss that might occur in the conduits between these points.

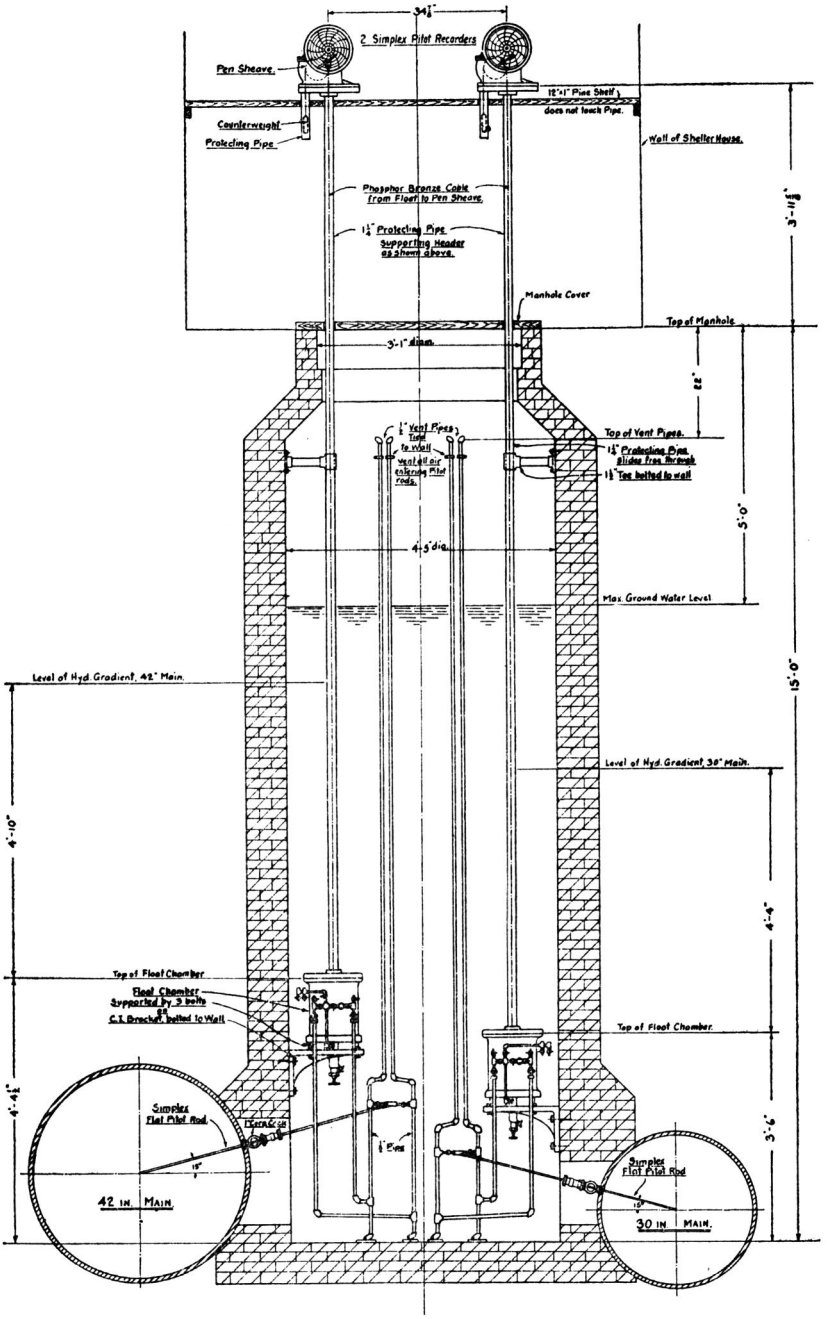
While Venturi meters are undoubtedly best adapted for measuring the flow in large mains, the impracticability of installing such meters on the conduits already laid was evident, interruption of the service being out of the question. For this reason it was decided to install Pitot Tube Recorders on the conduits at the Lake.

Four Simplex Recorders were furnished and put in place by the Simplex Valve and Meter Company of Philadelphia, two at the Lake, and two at the north gate house at the reservoir. While the installation at the reservoir presented no unusual difficulties, that at the Lake proved to be more or less out of the ordinary, and emphasizes the adaptability of the Pitot Tube for this work under unfavorable conditions. The solution of the problem seemed of sufficient interest to present to the reader.

The location selected for tapping the conduits for this installation is about five hundred feet north of the Lake, where the lines are practically parallel, and about six feet apart, on a tangent 100 feet long, making it possible to include both taps, and their float chambers, in a single manhole of reasonable size.

A brick manhole 4 feet 6 inches in diameter at the bottom, which was as large as could be built between the conduits, and about 16 feet deep was constructed, with side wells covering the mains to allow for connections, and housed over with a wooden building, 7 feet by 9 feet, to shelter the recorders. Considerable difficulty was encountered in making the excavation for this structure, on account of soft clay and quicksand, together with a large amount of percolation of ground water into the pit, making it impossible to keep the excavation open long enough to obtain a traverse on the outer tap, on the 42-inch line, which had to be abandoned. The coefficient used for this main was necessarily obtained as the result of traverses on one diameter only, making an angle of about 15 degrees with the horizontal. On the 30-inch main traverses were made on diameters 90 degrees apart, making an angle of about 15 degree from normal.

The hydraulic grade line, at this point, is approximately 7 feet 6 inches above the conduits, and the maximum ground water level about 10 feet above the bottom of the manhole. On account of slight joint leaks in the brick work in this manhole, the water normally stands at from 5 to 6 feet above the pipes. Under these



ARRANGEMENT OF SIMPLEX PITOT RECORDERS ON WATER FEED MAINS IN SYRACUSE

conditions it was impossible to locate the registering mechanism at the same elevation as the meter, which, of necessity, should be situated as far below the grade line as possible to obtain a suitable working head. The problem was readily solved by the engineers of the Simplex Company, by slight changes in their standard equipment, in the following manner. A special head was made and substituted for the regular head for the float chamber which was supported on brackets bolted to the sides of the manhole, and into this head a riser pipe, $1\frac{1}{4}$ inches in diameter, was tapped, extending upward 19 feet 6 inches above the chamber, supporting the regular head and registering device. A counterweighted phosphor-bronze cable through this pipe transmits the movement of the float in the chamber, to the sheaf controlling the recording pen. The coefficient of expansion of the pipe and cable being very nearly the same, any possibility of error in the chart reading on account of expansion or contraction in such a long pipe is eliminated.

The method of air-venting the float chamber and pitot tubes is somewhat unique, is automatic in action, and avoids the necessity of the attendant entering the pit to blow off the meters. The pitot tube was permanently connected with $\frac{1}{2}$-inch galvanized pipe, the meter connection being made at the under side of the tee connection on the pitot rod, and the upper side of the tee connected to a $\frac{1}{2}$-inch vertical pipe extending upwards to the top of the manhole. Any air that otherwise might collect in the rod automatically escapes through this vent.

On account of the unusually low head under which these meters operate, it would be reasonable to expect that these meters would be somewhat sluggish, but our experience with them has shown that they are as sensitive as any of the others which are installed on our system under much greater working heads. Repeated tests show that they check within 2 per cent of the manometer readings, at any time. The mean velocity in the 42-inch line, when discharging into the reservoir, averages 2.74 feet per second, and in the 30-inch line, 4.93 feet per second.

This Bureau now owns and operates nine Simplex Pitot Recorders, eight stationary and one portable, the latter being in use on water waste surveys. All are giving excellent service. The portable meter, in the past three years, has seen a good deal of hard service on these surveys, and has travelled many miles by truck over the city streets. In spite of such usage, with the exception of several acci-

dents, it has cost practically nothing for maintenance. During this period, over 5½ million gallons per day of waste or leakage have been detected by means of this meter.

The original installation of Simplex Recorders in this city proved conclusively the accuracy and reliability of such instruments. This meter was connected to the 24-inch high service feed main from the standpipe, the tap being located a few feet from the outlet valve, giving a somewhat unusual opportunity to check its performance, by comparing the drop in the standpipe, over a fixed time, with the chart readings. The results of this test, as shown below, demonstrate the accuracy of measurement of flow by means of Pitot Tube Recorders.

ELEVATION OF WATER IN STAND PIPE	DROP OF WATER LEVEL	DURATION	AVERAGE RATE OF FLOW PER 24 HOURS		PER CENT ERROR	AVERAGE VELOCITY FEET PER SEC.
			By stand-pipe	By Simplex recorder		
feet	*feet*	*hours*	*gallons*	*gallons*		
72.83						
	10.69	8	822,000	811,000	−1.25	0.512
62.14						
71.19						
	7.05	3	1,445,000	1,439,000	−0.45	0.909
64.14						
69.75						
	7.08	2¾	1,583,000	1,588,000	+0.40	1.745
62.67						
71.19						
	21.40	4¾	2,765,000	2,780,000	+0.40	1.000
49.79						
60.58						
	10.79	1¾	5,300,000	5,300,000	0.00	3.350
49.79						